

PROCEEDINGS  
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THE SCALES OF THE SIMENCHELYID, OPHIDIID,  
BROTULID AND BREGMACEROTID FISHES.

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I am greatly indebted to Mr. C. Tate Regan, of the British Museum, for scales of four families of fishes which I had not previously been able to study. The specimens prove not merely interesting, as representing undescribed forms, but quite remarkable for the light they seem to throw on the structure and relationship of other scales.

SIMENCHELYIDE.

*Simenchelys parasiticus*. North Atlantic. The minute scales are about  $720\mu$  long and 225 broad, thus greatly elongated, and rounded at the ends. The scale consists of concentric rows of minute oblong elements, which, when the scales are broken, rather readily come apart. These structures are identical in general character with the separate elements described and figured by H. W. Maret Tims (Quart. Journ. Mic. Sci., 49, Oct., 1905, pl. 6) as occurring in *Gadus*. Essentially the same thing is found in *Synaphobranchus pinnatus*. The structural resemblance between the scales of the eels and those of the Brotulidae, Gadidae, etc., is astonishing.

OPHIDIIDE.

*Genypterus blacodes*. Tasmania. Scales about 2 mm. long and  $1\frac{1}{3}$  broad, usually distinctly subtriangular, with the corners obtuse. The numerous radii extend in every direction from the nucleus, and the whole scale is divided into small transversely elongate plates, precisely in the manner of *Gadus*. The plates are very minutely beaded or nodulose on the outer (laterad) side, a fact first noted by Dr. Max Ellis, who examined the scales with me. Some of the radii are incomplete, as may be seen in *Gadus* (Tims, l. c., pl. 6, f. 6). Except for the subtriangular shape and the minute nodulosity of the outer sides of the plates, I do not know how the scale of *Genypterus* can be separated from that of *Gadus*.

## BROTULIDÆ.

*Brotula maculata*. Madras. Scales about  $4\frac{2}{3}$  mm. long and 2 broad, thus greatly elongated, with broadly rounded ends, approaching somewhat in shape the scales of the eels. The sides are subparallel, and the nucleus is far (a variable distance) toward the base. The extremely numerous radii extend in all directions from the nucleus, and the whole scale is divided into small transverse blocks or plates, exactly as in *Gadus*. The sculpture is very regular, fine and beautiful. Some of the plates, especially the outer lateral ones, have the outer margin very minutely granular or microscopically crenulate, an approach to the condition found in *Genypterus*. The scales can not be said to differ in any important character from those of the Gadidæ, or from those of *Genypterus*. *Brosme* in the Gadidæ has long and narrow scales.

*Neobythites steaticus*. Persian Gulf. Scales oblong with rounded ends, about  $3\frac{1}{4}$  mm. long and 2 wide, the nucleus near the base; the radii extending in every direction, but not nearly so close as in *Brotula maculata*. The general form and structure of the scale is as in *Gadus callarias* or *Brotula*, but there is an important difference in the plates of the central part of the scale apical of the nucleus, which are squarish, and in the middle line become much longer than broad, while their surface is ornamented with irregular and minute but very strong and distinct reticulations. The elongated basal and lateral plates are without this reticulation. One scale has the nuclear area broadly ornamented with fine striae in irregular bundle-like groups, gradually passing apical into the reticulation already mentioned. Dr. Max Ellis calls my attention to the extraordinary resemblance between these structures and those of certain Gymnotidæ. Thus a scale of *Sternarchus brasiliensis* shows the reticulation of the plates; while *Gymnotus carapo* and *Adontosternarchus sachsii* show the bundle-like striae to perfection. The whole structure of the Gymnotid scale is also extremely suggestive of the Brotulid-Gadid type.

Regan (Ann. Mag. Nat. Hist., Sept., 1912, pp. 277-279) places the Brotulidæ, Ophidiidæ and Fierasferidæ together in a division Ophidiiformes. The Fierasferidæ are without scales.

## BREGMACEROTIDÆ.

*Bregmaceros atripinnis*. Bombay. This genus is placed by Boulenger and Goodrich in the Gadidæ, but the scales are very peculiar. They are about  $1\frac{1}{2}$  mm. long, 1 mm. or a little more in width, very broadly rounded apically, parallel-sided, and with the very broad base truncate, the truncation usually with a distinct but low median angular projection. The nucleus is a little basad of the middle, varying to practically central. *The coarse circuli of the basal field are wholly longitudinal*, curving over to meet above the nucleus, so that all the circuli of the region apical of the nucleus are concentric as usual. Just above the nucleus the meeting circuli form a regular broad arch, but beyond this most of them, in the majority of scales, form a conspicuous angle at the point of junction.

Sometimes the angulation of the circuli is to one side of the middle line. Between the circuli are very numerous squarish to suboval plates, corresponding to the plate-like elements described in the *Gadidae*, etc., but square or higher than wide, never transversely widened. In the basal region, where the circuli are longitudinal, the plates fuse together to form longitudinal ridges. In this region the intervals or sutures between the rows of fused plates, the true circuli, are finely and regularly beaded.

This remarkable scale may perhaps be the key to the understanding of scale structure, and if so, it must be held to confirm the Timsian theory of the development of scales from placoid-like elements. It is at any rate impossible to doubt that the basal longitudinal ridges between the circuli are formed by the fusion of the small squarish bodies which are seen just above, and gradually pass into the ridges. We also seem to see the manner of origin of the beaded circuli of the *Osteoglossidae*, etc. On this view, it is easy to understand why the fine longitudinal basal fibrillæ of *Albula* present a minutely segmented appearance. Such a view will, however, force us to conclude that the *Amia calva* scale is not primitive in structure, the fine solid longitudinal fibrillæ representing the perfection of the tendency which we observe in *Bregmaceros*. The relative positions of these fishes in the Ichthyological system is certainly against this view, but it is possible that *Amia* has specialized scales.

Whatever *Bregmaceros* may or may not prove in relation to scales in general, it is certainly significant in relation to the two quite distinct groups of Gadoid scales indicated in Proc. Biol. Soc. Wash., xxiv, p. 212. *Urophycis* and *Enchelyopus* show beaded circuli; in *Urophycis regius* the basal circuli are practically longitudinal, though converging toward the middle, while followed round to the middle of the apical field, they meet at an acute angle. The *Merluccius* scale, apical of the nucleus, shows a fine reticulation between the circuli, exactly corresponding with that in *Neobythites*.